DOCUMENT RESUME

ED 448 202 TM 032 232

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TITLE Statistics Anxiety: Nature, Etiology, Antecedents, Effects, and Treatments: A Comprehensive Review of the Literature.
PUB DATE 2000-11-15
NOTE 34p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (28th, Bowling Green, KY, November 17-19, 2000).
PUB TYPE Information Analyses (070) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; *Anxiety; *College Students; Higher Education; Literature Reviews; *Statistics

ABSTRACT

Many college students are required to enroll in statistics and quantitative research methodology courses as part of their degree programs, but many students report high levels of anxiety while enrolled in these classes. Recent years have seen an increase in the number of articles on statistics anxiety appearing in the literature as researchers have recognized that statistics anxiety is a multidimensional construct that has debilitating effects on academic performance. This paper provides a summary of the literature on statistics anxiety, describing the nature, etiology, and prevalence of statistics anxiety. The antecedents (dispositional, situational, and environmental) of statistics anxiety are identified, and their effects on achievement in statistics are traced. Existing measures of statistics anxiety are described, and an array of successful interventions for reducing statistics anxiety are discussed. (Contains 1 figure and 81 references.) (Author/SLD)

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Statistics Anxiety: Nature, Etiology, Antecedents, Effects, and Treatments: A Comprehensive Review of the Literature

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TM032232

Paper presented at the annual meeting of the Mid-South Educational Research Association, Lexington, Kentucky, November 15, 2000.

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Abstract

Most college students are required to enroll in statistics and quantitative research methodology courses as a necessary part of their degree programs. Unfortunately, many students report high levels of statistics anxiety while enrolled in these classes. Although statistics has been taught formally throughout much of the 20th century, few studies existed pertaining to statistics anxiety prior to the last decade. However, recent years has seen an increase in the number of articles on statistics anxiety appearing in the literature, as researchers have recognized that statistics anxiety is a multidimensionality construct that has debilitative effects on academic performance. Thus, the purpose of this presentation is to provide a comprehensive summary of the literature on statistics anxiety. In particular, the nature, etiology, and prevalence of statistics anxiety are described. Additionally, the antecedents (i.e., dispositional, situational, and environmental) of statistics anxiety are identified, as well as their effects on statistics achievement. Further, the existing measures of statistics anxiety are documented. Finally, based on the literature, an array of successful interventions for reducing statistics anxiety are described.

Statistics Anxiety: Nature, Etiology, Antecedents, Effects, and Treatments: A Comprehensive Review of the Literature

As the need for the application of statistical techniques has increased over the years, so more college students are required to enroll in statistics courses as a necessary part of their degree program. Since many of these students come from diverse academic backgrounds, some of which appear far removed from the field of statistics, taking a statistics course is often a negative experience. Indeed, Lalonde and Gardner (1993) and Lazar (1990), and Onwuegbuzie (2000c) suggest that learning statistics is similar to learning a foreign language. Consequently, many students report high levels of anxiety while enrolled in statistics courses.

According to Onwuegbuzie (in press), between two-thirds and four-fifths of graduate students appear to experience uncomfortable levels of statistics anxiety. Indeed, for many students, statistics is one of the most anxiety-inducing courses in their programs of study (Blalock, 1987; Caine, Centa, Doroff, Horowitz, & Wisenbaker, 1978; Gaydosh, 1990; Lundgren & Fawcett, 1980; Schacht & Stewart, 1990, 1991; Zeidner, 1991). The levels of statistics anxiety experienced by students can be so great that undertaking research methodology and statistics classes has come to be regarded by many as extremely negative (Onwuegbuzie, 1997a), and perhaps, more importantly, a major threat to the attainment of their degrees. In fact, as a result of anxiety, students often delay enrolling in research methods and statistics courses for as long as possible, sometimes waiting until the final semester of their degree programs--which is clearly not the optimal time to undertake such courses (Onwuegbuzie, 1997a, 1997b; Robert & Bilderback, 1980).

Onwuegbuzie, DaRos, and Ryan (1997) defined statistics anxiety as an anxiety which occurs when a student encounters statistics in any form and at any level. Zeidner (1990) defined statistics anxiety more specifically as:

> a performance characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal ...when exposed to statistics content, problems, instructional situations, or evaluative contexts, and is commonly claimed to debilitate performance in a wide variety of academic situations by interfering with the manipulation of statistics data and solution of statistics problems. (p. 319)

Antecedents of Statistics Anxiety

Perney and Ravid (1990) contended that mathematics anxiety is transferred to statistics courses. Both Bendig and Hughes (1954), who studied the relationship between student attitude and statistics achievement, and Fisch (1971), who studied the effects of a variety of cognitive and affective variables on statistics achievement in a German university, found a relationship between situational anxiety and performance. Thus, it seems reasonable to assume that the antecedents of statistics anxiety can be categorized as situational, dispositional, and environmental. Situational antecedents refer to factors which surround the stimulus, whereas dispositional antecedents refer to factors which an individual brings to the setting. Finally, environmental antecedents refer to events which occurred in the past. The major difference between a dispositional and an environmental antecedent is that the former is internal to the person, whereas the latter is external (Byrd, 1982).

Situational Antecedents of Statistics Anxiety

Using an instrument called the Statistics Attitude Survey (Roberts & Bilderback, 1980), Roberts and Saxe (1982) found significant correlations between statistics anxiety and basic mathematics skills, statistics prior knowledge, statistics course grade, number of prior mathematics courses completed, the status of the course (i.e., required or elective), attitudes towards calculators, course and instructor evaluation, satisfaction with the statistics course, and gender. Zeidner (1991) also found that amount of prior exposure to mathematics and poor prior achievement in mathematics influenced the level of statistics anxiety. Similarly, Trimarco (1997) noted that students who reported having the greatest breadth of knowledge of research and statistics also tended to report the lowest levels of anxiety.

Morris, Kellaway, and Smith (1978) found that non-statistics majors who were enrolled in an introductory statistics class had significantly higher levels of mathematics anxiety than did mathematics students enrolled in mathematics classes. Additionally, these researchers found an inverse relationship between mathematics anxiety and statistics achievement. Hunsley (1987) also discovered a negative relationship between mathematics anxiety and statistics achievement. Benson (1989) found that statistics test anxiety is negatively related to both mathematics self-concept and statistics achievement. Similarly, Harvey, Plake, and Wise (1985) reported a negative correlation between mathematics anxiety and academic performance in a statistics examination. However, they were unable to establish a causal link.

Sells (1978) asserted that mathematics anxiety is largely responsible for the

negative attitudes that are inherent in most sociological statistics courses. Also, Topf (1976) noted that graduate nursing students attributed their lack of knowledge of statistical concepts to anxiety about quantitative subject matter. Similarly, Zanakis and Valenza (1997), in an investigation of undergraduate students enrolled in a business statistics course, found that statistics anxiety was strongly related to test anxiety and understanding of statistical concepts prior to taking the statistics course. Similarly, Wilson (1997) and Tomazic and Katz (1988) found a statistically significant negative relationship between level of statistics anxiety and number of mathematics courses taken in high school and college.

Wilensky (1997) contended epistemological anxiety as the major source of statistics anxiety. Epistemological anxiety was defined as "a feeling, often in the background, that one does not comprehend the meanings, purposes, sources or legitimacy of the mathematical objects one is manipulating and using (Wilensky, 1997, p. 172).

Dispositional Antecedents of Statistics Anxiety

Zeidner (1991) found that perceived level of mathematics self-concept and level of self-esteem are important contributors to statistics anxiety. Most recently, Onwuegbuzie (2000a) revealed that students with the lowest levels of perceived scholastic competence, perceived intellectual ability, and perceived creativity tend to have the highest levels of statistics anxiety associated with worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of the statistics instructor.

Another dispositional factor found to be related to statistics anxiety is perfectionism.

Specifically, Onwuegbuzie and Daley (1999) reported that graduate students who hold unrealistic standards for significant others (i.e., other-oriented perfectionists) and those who maintain a perceived need to attain standards and expectations prescribed by significant others (i.e., socially-prescribed perfectionists) tend to have higher levels of statistics anxiety associated with interpretation anxiety, test and class anxiety, computational self-concept, and fear of asking for help than do their less-perfectionistic counterparts.

Academic procrastination also has been linked to statistics anxiety. Specifically, Onwuegbuzie (2000b) found that overall academic procrastination was significantly positively related to the following dimensions of statistics anxiety: interpretation anxiety, test and class anxiety, and fear of asking for help. A follow-up canonical correlation analysis revealed that academic procrastination resulting from both fear of failure and task aversiveness was related significantly (R_{c1} = .51) to worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of the statistics instructor.

Snyder et al. (1991) identified two elements of hope: agency and pathways. According to these authors, these two elements help to explain how goals are pursued. The agency element refers to a sense of hope that is stimulated by the perception of successful determination in meeting goals in the past, present, and future; whereas the pathways element concerns the perception of being able to create successful strategies to meet goals. In this respect, these two elements are "reciprocal, additive, and positively related" (Snyder et al., 1991, p. 571). In order for individuals to maintain progress towards

their life goals, both the sense of agency and the sense of pathways must be functional. Interestingly, Onwuegbuzie (1998b) found that students who had the poorest sense of successful determination in relation to their goals, and who had the least positive appraisals of their ability to generate ways to overcome goal-related obstacles and to reach their goals tended to have the highest level of anxiety associated with worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of the statistics instructor.

Onwuegbuzie and Daley (1997) assessed the role of Gardner's (1983) theory of multiple intelligences in determining levels of statistics anxiety among 90 public school teachers enrolled in an educational research methodology course. A canonical correlation analysis revealed that teachers who were less oriented toward linguistic and logical-mathematical intelligence and more oriented toward spatial and interpersonal intelligence tended to have higher levels of statistics anxiety.

Sutarso (1992) found significant relationships between students' anxiety in learning statistics and statistical preknowledge. Interestingly, Farbey and Roberts (1981) found a large increase in state anxiety between easy and difficult tasks when solving statistical problems by hand. However, no difference in level of anxiety was observed between easy problems solved by hand and difficult problems solved with the aid of the calculator. These researchers advocated the use of calculators for reducing levels of anxiety.

Onwuegbuzie and Daley (1996) conducted an experimental investigation examining the contributions made by both examination-taking coping strategies and study coping strategies on the anxiety/performance relationship, under two types of examination

conditions. Graduate students, who were enrolled in an intermediate-level statistics course, were assigned randomly to either an untimed or a timed examination condition. Both types of coping strategies made a significant contribution in explaining variance in test anxiety. Overall, students in the timed condition performed more poorly than did students in the untimed condition. A significant interaction was found between examination-taking coping strategies and examination condition: students with poor coping strategies did not perform as well in the timed as in the untimed condition. No such interaction was found between study coping strategies and examination condition. According to Onwuegbuzie and Daley, these findings are consistent with an information processing interpretation, which suggests that different processes related to test anxiety affect examination performance.

Environmental Antecedents of Statistics Anxiety

A few researchers have investigated gender differences in statistics anxiety. Specifically, Benson (1989) and Benson and Bandalos (1989) found that females reported higher levels of statistical test anxiety than did males. Additionally, in an examination of psychology students at a small liberal arts college, Bradley and Wygant (1998) discovered that although females reported statistically significantly higher levels of anxiety about taking statistics courses than did their counterparts, their achievement scores at the end of two statistics courses were not statistically significantly different than scores attained by males. Finally, Demaria-Mitton (1987), who studied statistics anxiety in an introductory statistics course, found that statistics anxiety was experienced by both sexes. However, female subjects reported more statistics anxiety than did males. Statistics anxiety was related to

age, with students more than 20 years of age experiencing more anxiety than did their younger counterparts. However, the results of Demaria-Mitton may not be valid because she used a modified version of the Mathematics Anxiety Rating Scale (MARS; Richardson & Suinn, 1972) to measure statistics anxiety.

Racial differences also have been found with respect to statistics anxiety. Specifically, Onwuegbuzie (1999) noted that African-American graduate students at a university in the mid-southern United States reported higher levels of statistics anxiety associated with *worth of statistics*, *interpretation anxiety*, and *test and class anxiety* than did their Caucasian-American counterparts. These differences ranged from .45 to .56 standard deviations, suggesting moderate effect sizes. Similarly, using Cruise, Cash, and Bolton's (1985) Statistics Anxiety Rating Scale, Bell (1998) found that international students reported statistically significantly higher levels of statistics anxiety (i.e., interpretation anxiety, computational self-concept, fear of asking for help, and fear f the statistics teacher) than did their non-international counterparts. However, extreme caution should be exercised in interpreting this finding because the number of international students in the study (I = 10) was very small, and no adjustment to the Type I error was made, despite the fact that multiple tests of significance were performed.

Learning styles also have been implicated as being an antecedent to statistics anxiety. In particular, Onwuegbuzie (1998c) found that classroom design, structure of the course, authority-orientation, auditory-orientation, food intake preference, time of day preference, and mobility preference, are related to worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking for help, and fear of

statistics teachers, to varying degrees.

Effects of Statistics Anxiety

A growing body of research has documented a consistent negative relationship between statistics anxiety and course performance (Elmore, Lewis, & Bay, 1993; Lalonde & Gardner, 1993; Onwuegbuzie & Seaman, 1995; Zeidner, 1991). In fact, statistics anxiety has been found to be the best predictor of achievement in research methodology (Onwuegbuzie, Slate, Paterson, Watson, & Schwartz, in press) and statistics courses (Fitzgerald, Jurs, & Hudson, 1996). Similarly, Feinberg and Halperin (1978) found that level of state anxiety was more predictive of statistics achievement than was level of trait anxiety. They contended that affective variables such as state anxiety are more closely related to students' expectation of statistics achievement than are cognitive variables.

Consistent with Feinberg and Halperin's (1978) conclusions, Onwuegbuzie (2000c), using path analytic techniques, found that statistics anxiety and expectation play a central role in his Anxiety-Expectation Mediation (AEM) model, being related bi-directionally to statistics achievement, and, at the same time, moderating the relationship between statistics achievement and research anxiety, study habits, course load, and the number of statistics courses taken. The AEM model is presented in Figure 1. Onwuegbuzie (2000c) posited that the pivotal role of statistics anxiety in the AEM model suggests that Wine's (1980) Cognitive-Attentional-Interference theory can be applied to the field of statistics, as it can be to the foreign language learning context. According to Onwuegbuzie, Wine's theory predicts that anxiety interferes with performance by impeding students' ability to receive, to concentrate on, and to encode statistical terminology, language, formulas, and

concepts. Moreover, Onwuegbuzie theorized that anxiety reduces the efficiency with which memory processes are utilized while attempting to understand and to learn new statistical material, making it difficult to solve statistical problems.

Insert Figure 1 about here

Moreover, a causal link between statistics anxiety and course achievement has been established. In particular, Onwuegbuzie and Seaman (1995) found that graduate students with high levels of statistics test anxiety who were randomly assigned to a statistics examination that was administered under timed conditions tended to have lower levels of performance than did their high-anxious counterparts who were administered the same test under untimed conditions. In a follow-up experimental investigation among female college students, Onwuegbuzie (1995) reported a significant interaction between statistics test anxiety and type of examination(i.e., timed vs. untimed), with high-anxious female students showing a greater decrement in performance than did low-anxious female students in the untimed examination condition. Onwuegbuzie interpreted these results within conceptual frameworks developed by Hill (1984) and Wine (1980), who suggested that differences between high- and low-anxious students in evaluative situations are due to differences in motivational dispositions and attentional foci, respectively. Additionally, using qualitative techniques, Onwuegbuzie (1997a) reported that statistics anxiety primarily affects a student's ability fully to understand research articles, as well as to analyze and to interpret statistical data.

Multidimensionality of Statistics Anxiety

Statistics anxiety has been conceptualized as being multidimensional (Cruise et al., 1985; Cruise & Wilkins, 1980; Onwuegbuzie, 1997a, Onwuegbuzie et al., 1997; Zeidner, 1991). Zeidner (1991), who compared statistics anxiety to mathematics anxiety, reported that statistics anxiety comprised the following two dimensions: statistics test anxiety and content anxiety. In an in-depth phenomenological study, Onwuegbuzie et al. (1997a) identified four general components of statistics anxiety, namely, instrument anxiety, content anxiety, interpersonal anxiety, and failure anxiety. Apparently, each of these components comprise several subcomponents. According to these authors, instrument anxiety consists of computational self-concept and statistical computing anxiety. Content anxiety comprises fear of statistical language, fear of application of statistics knowledge, perceived usefulness of statistics, and recall anxiety. Interpersonal anxiety is composed of fear of asking for help and fear of statistics instructors. Finally, failure anxiety consists of study-related anxiety, test anxiety, and grade anxiety.

Using factor analysis, Cruise et al. (1985) identified six components of statistics anxiety, namely: (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics teachers. Additionally, Onwuegbuzie (1997a) reported that the following four dimensions of statistics anxiety are experienced by graduate students while they are engaged in writing research proposals: perceived usefulness of statistics, fear of statistical language, fear of application of statistics knowledge, and interpersonal anxiety.

Using Cruise et al.'s (1985) conceptualization, Onwuegbuzie (1998a) documented

that test and class anxiety is the greatest source of statistics anxiety. Apparently, test and class anxiety had statistically significantly higher mean ratings than did the other dimensions of statistics anxiety, namely: worth of statistics, interpretation anxiety, computational self-concept, fear of asking for help, and fear of statistics teachers. The effect sizes associated with these differences, as measured by Cohen's (1988) *d*, ranged from .62 to .90, suggesting large differences. Interpretation anxiety, which was the second most prevalent dimension, had statistically significantly higher mean ratings than did the four remaining dimensions.

Measures of Statistics Anxiety

Although several instruments have been developed to measure attitudes toward statistics (e.g., Roberts & Bilderbach, 1980; Schau & Stevens, 1995; Wise, 1985), very few direct measures of statistics anxiety currently exist. Unfortunately, the vast majority of research studies undertaken on statistics anxiety have used measures of mathematics anxiety, in particular the MARS (Richardson & Suinn, 1972). Because mathematics anxiety and statistics anxiety are related but separate constructs, the validity of using measures of mathematics anxiety is in question.

An extensive review of the literature, only three scales which directly measure statistics anxiety were found. These were the Statistics Anxiety Scale (SAS; Pretorius & Norman, 1992), the Multifactorial Scale of Attitudes Toward Statistics (MSATS; Auzmendi, 1991), the Statistics Anxiety Inventory (STAI; Zeidner, 1991), an un-named instrument measure of statistics anxiety and attitudes developed by Zanakis and Valenza (1997), and the Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985),

The SAS (Pretorius & Norman, 1992) consists of one scale measuring global statistics anxiety. Although the MSATS is designed to measure attitudes toward statistics, one of the five dimension of this scale measures levels of statistics anxiety. Zeidner's (1991) STAI is a 40-item instrument containing the following two subscales; anxiety about statistics content and anxiety about statistics performance and problem-solving capacity in evaluative situations. Zanakis and Valenza's (1997) 36-item measure of statistics anxiety and attitudes contains the following six subscales: (a) Student Interest in and Perceived Worth of Statistics; (b) Anxiety When Seeking Help for Interpretation, (c) Computer Usefulness and Experience, (d) math Anxiety, (e) Understanding, and (f) Test Anxiety. However, Zanakis and Valenza's (1997) scale does not appear to have been used in any other investigation.

Cruise et al.'s (1985) STARS presently is the most utilized measure of statistics anxiety. The STARS comprises six components of statistics anxiety, namely: Worth of Statistics, Interpretation Anxiety, Test and Class Anxiety, Computational Self-Concept, Fear of Asking for Help, and Fear of Statistics Teachers. According to these authors, *worth of statistics* refers to a student's perception of the relevance of statistics. *Interpretation anxiety* is concerned with the anxiety experienced when a student is faced with making a decision from or interpreting statistical data. *Test and class anxiety* refers to the anxiety involved when taking a statistics class or test. *Computational self-concept* involves the anxiety experienced when attempting to solve mathematical problems, as well as the student's perception of her/his ability to do mathematics. *Fear of asking for help* measures the anxiety experienced when asking a fellow student or professor for help in

understanding the material covered in class or any type of statistical data, such as an article or a printout. *Fear of statistics teachers* is concerned with the student's perception of the statistics instructor.

The Treatment of Statistics Anxiety

Despite the prevalence of statistics anxiety and the obvious pervasive and debilitative nature of this construct, it is surprising that only a few researchers have investigated ways of reducing statistics anxiety. Specifically, Schacht and Stewart (1990) reported that students in statistics classes where humorous cartoon examples were incorporated, perceived a reduction in their level of mathematics anxiety. For these same students, a reduction in the actual level of their mathematics anxiety was confirmed, although the exact causal nature of this reduction could not be established, because an experimental design was not employed. It is highly likely that interventions for different presentations of statistics anxiety may be different, depending on the manner in which it is manifested by each individual. For example, a student who has unpleasant physiological reactions in examination situations may benefit from a different type of intervention to a student who has a negative view of their propensity or ability to succeed. The former may benefit from biofeedback training, whereas the latter may benefit from some form of cognitive intervention. In a follow-up article, Schacht and Stewart (1990) advocated the teaching gimmicks in statistics classes. These gimmicks include using students as the source from which data are collected and allowing students to create the statistical application. Sgoutas-Emch and Johnson (1998) found journal writing to be effective in reducing levels of anxiety, although these authors did not find a statistically significant

decrease in anxiety levels. For statistics-anxious females Nielsen (1979) recommended that they be taught by female professors.

Dillon (1982) described a method used to reduce mathematics anxiety in college-level statistics courses. Specifically, students share apprehension and anxiety about statistics and receive a lecture concerning ways of coping with their anxieties. At the end of the course, students again share their perceptions and feelings and attempt to appreciate their increased mastery of statistical concepts.

Onwuegbuzie (2000d) found that examinations that are untimed and in which supporting material is allowed are regarded by the majority of students as inducing the least amount of anxiety, as increasing levels of performance, and as promoting higher-order thinking. In fact, students tend to rate performance assessments more highly than other examination formats. Performance assessments involve providing students with projects, tasks, assignments, or investigations, then evaluating the products that emerge in order to assess what students have learned and what they can accomplish (Stenmark, 1991). As noted by educators and researchers alike (e.g., Fuchs, 1995; Wiggins, 1989; Worthen, 1993), performance assessment tasks should reflect essential, meaningful, and interesting performances that are linked to desired student outcomes that are relevant to everyday life. That is, such methods of assessment should involve blending content with process and major concepts with specific problems (Baron, 1990). To this end, performance assessments should evaluate what students can do, in addition to what they know (Hutchinson, 1995), being based on observing, documenting, and analyzing student work (Davey & Neill, 1991).

According to Elliott (1995), when using performance assessments, the performance of students can be influenced positively by the following: 1) selecting assessment tasks that are aligned clearly and are connected to what has been taught; 2) delineating clearly the scoring criteria for the assessment task to students prior to working on the task; 3) providing students with clear statements of standards and/or various models of acceptable performance before they attempt a task; 4) encouraging students to undertake self-assessments of their performances; and 5) interpreting students' performances by comparing them to those of other students, as well as to standards that are developmentally appropriate. Thus, where possible, statistics instructors should consider utilizing performance assessments. The use of other types of statistics assessments also should be examined.

In a study of education and business students in graduate statistics courses, Wilson (1996) found that students thought humor and testing procedures (such as open book/open note testing) somewhat effective in reducing their anxiety levels, but that they were far more likely to attribute anxiety reduction to the teacher's behavior and personality. Especially effective was reassurance from the instructor that the students could successfully complete the assigned tasks.

Wilson (1999a) employed a systematic program of strategies purported in the literature to reduce statistics anxiety: addressing the anxiety, using humor, applying statistics to real-world situations, reducing fear of evaluation, and encouraging students to work in cooperative groups. Again, she found that the students perceived the interpersonal style of the instructor as more important than specific strategies in reducing levels of

anxiety. Addressing the anxiety actually increased some students' discomfort, and working in cooperative groups was anxiety reducing only when team members were known and trusted to complete high quality work.

In a ranking of 16 anxiety-relieving factors mentioned by students in previous research by the author (i.e., Wilson 1999b), students in a graduate educational research course placed having open book/open note tests and working with a partner in the computer lab at the top of the list. The instructor's positive attitude, encouragement, and reassurance were ranked next, followed by humor and addressing the anxiety. Scores for cooperative learning had the highest variability, showing that cooperative learning can both create and reduce anxiety, depending on the composition of the team.

Another investigation of students in a graduate educational research course (Wilson, 2000) showed that although instructors can do much to reduce levels of statistics anxiety, there is a certain amount of anxiety inherent in a class in which students are asked to learn and respond to information and processes with which they are unfamiliar, including mathematical procedures, statistical concepts, and research conventions. Outside factors, including family and job obligations and workload in other courses, add to the stress that graduate students experience in educational research classrooms.

Finally and most recently, utilizing Onwuegbuzie's (1998b) finding of a relationship between hope and statistics anxiety, Dilevko (2000) recommended that research methodology and statistics class activities attempt to help students with understanding the course objectives, as well as being cognizant of the goals of statistics in order to control their own learning goals. According to Dilevko, statistics anxiety can be reduced by

improving students' perceived worth of statistics and by decreasing their fear of applying statistical knowledge and principals. Dilevko suggested that a two-pronged approach be used to decrease statistics anxiety, namely: (a) using current news stories and similar sources to introduce and to explain basic statistical concepts and methodological issues in research; and (b) targeting their fear of application of statistics concepts by introducing students to older articles about subjects of interest, and asking them to read, to understand, and to critique these articles, and to suggest how the research projects described in them could be modified, expanded, and updated. Dilevko contends that as a result of these two strategies, the importance of statistics in everyday life is demonstrated through class discussion of interesting events reported in the popular press. Unfortunately, although appealing, Dilevko did not provide any research evidence of the efficacy of his strategies.

Directions for Future Research in the Area of Statistics Anxiety

As documented above, recently, there has been an increase in the number of researchers investigating the construct of statistics anxiety. However, there is still much that we do not know about this phenomenon. Moreover, much of the research in this area have been undertaken among undergraduate students. Yet, as noted by Onwuegbuzie (1998a), statistics anxiety is extremely prevalent among graduate students, especially among women and minorities. Furthermore, because theses and dissertations typically necessitate the use of statistics, and because a significant proportion of students do not complete their theses and dissertations, and hence their graduate degree programs (Bowen & Rudenstine, 1992; Cesari, 1990), it is possible that statistics anxiety, in part, may

prevent some graduate students, especially those who are most susceptible to anxiety, from completing their degree programs. As such, more investigations are needed among this often-neglected population, especially with respect to interventions.

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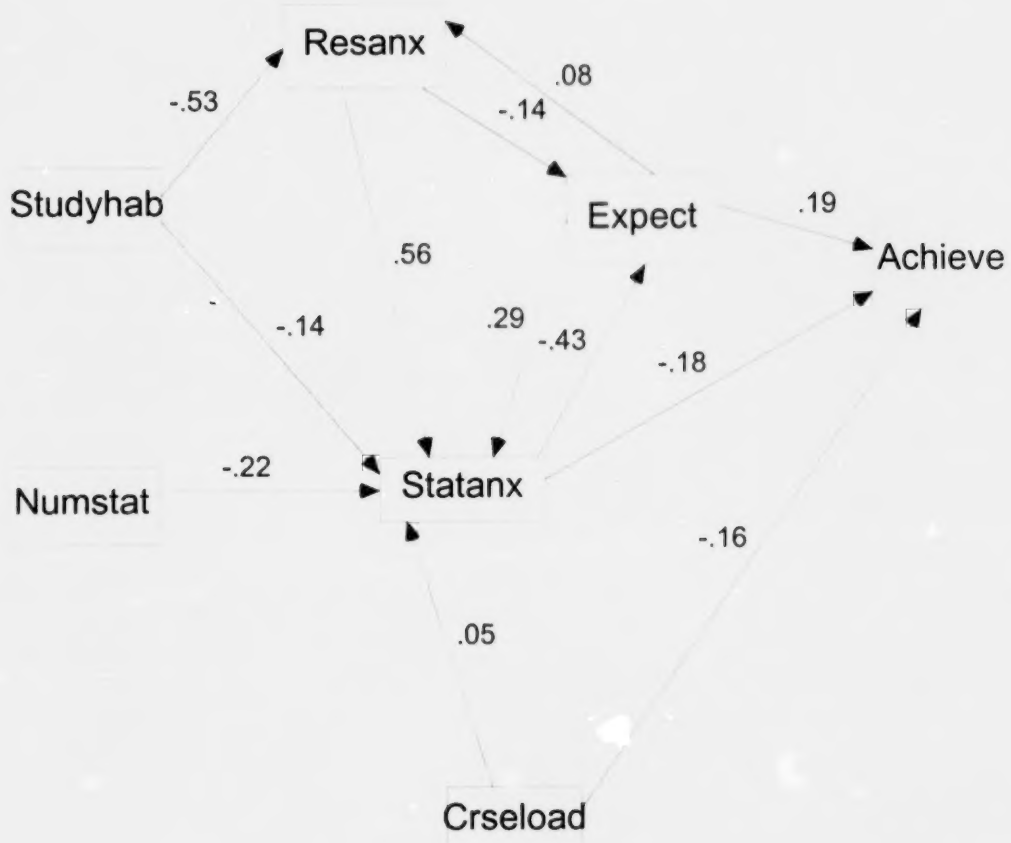
Figure 1.

Final Anxiety-Expectation Mediation (AEM) Model of Statistics Achievement Showing all Significant Paths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